

United States Department of Agriculture
Agricultural Research Administration
Bureau of Entomology and Plant Quarantine

GROWTH STAGES OF CORN AS RELATED TO EUROPEAN CORN BORER INFESTATION

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The nomenclature of corn-plant growth stages described in this paper includes specific definitions useful in reporting field experiments in the control of the European corn borer (Pyrausta nubilalis (Hbn.)). This arbitrary classification has been developed and is presented in response to the need experienced by the author and many other entomologists for a uniform, specific, and readily comprehensible terminology for use in describing the corn plant at the time when an observation is made or a treatment is applied. The use of plant height, number of days from planting or silking, and very loose terms, such as "tasseling" or "silking," does not provide an adequate concept of the growth stage of the plant to which reference is made. The accompanying illustrations, tables, and definitions have been developed from extensive field studies¹ of the growth habits of various types and strains, and the nomenclature has been found applicable to most of the common commercial varieties of corn. Further designation of growth periods within the subdivisions itemized here is practicable for special purposes as required.

The illustrations of corn-plant growth stages (figs. 1-3) are semi-diagrammatic. An effort has been made to keep the drawings to scale and to show the normal growth and development of all parts of the corn plant. This has required considerable generalization. The growth stages recognized, together with symbols useful in designating them, are listed as follows:

Pre-whorl	(P _W)	Late green tassel	(T ₃)
Early whorl	(W ₁)	Early silk	(S ₁)
Mid-whorl	(W ₂)	Mid-silk	(S ₂)
Late whorl	(W ₃)	Late silk	(S ₃)
Early green tassel .	(T ₁)	Roasting ear	(R.E.)
Mid green tassel ...	(T ₂)	Mature	(M)

¹/ The studies were conducted near New Haven, Conn., in commercial fields of sweet corn. Hybrids derived from Golden early Market, Golden Cross Bantam, and various other northern strains of sweet and field corn were used in developing the classification.

The characters found most useful in distinguishing the several growth stages of corn are itemized in tables 1 and 2. These tables include several terms, the definitions of which are reviewed here for the readers' convenience.

The primary leaf blades are the first parts of the plant to make their appearance above ground. They are turgid and functional throughout the pre-whorl and the early whorl growth stages. Then they begin to shrivel, split, and become brown. Cultivation usually buries the primary leaf blades before the plant reaches the late-green-tassel stage.

A rolled leaf blade is one that is rolled at its base and does not show a distinct line of juncture with its leaf sheath, the line of juncture being hidden by leaf blades originating at points lower on the stalk.

An unrolled leaf blade is one that, through expanding growth, has separated itself from the whorl and shows a distinct line of juncture with its leaf sheath.

The leaf sheath is the part of the leaf that is attached to and wrapped around the stalk.

The peduncle, or tassel stem, is the part of the stalk that extends from the topmost leaf sheath to the lowermost tassel branch. It is not seen until the late-green-tassel stage, when a small part is visible in some varieties.

Husk laminae, or "streamers," are bladelike extensions from the husk leaves.

An ear shoot is any immature ear produced by the plant prior to and including the early silk stage of growth. With further development the topmost ear shoots become true ears and the remainder become rudimentary ears.

A rudimentary ear is one that produces silk, but its kernels are usually sterile and incapable of more than rudimentary growth. In this respect it differs from a nubbin, or small ear, some of the kernels of which have been fertilized.

Table 1.--Characteristics of the whorl (fig.1) and green-tassel (fig.2) growth stages of the corn plant (based on examination of 100 plants)

Growth stage	Primary leaf blades <u>1/</u>	Leaf blades visible <u>2/</u>	Rolled leaf blades composing <u>3/</u> whorl	Tassel appearance	Ear shoots	Anthers	Length of husk laminae
		<u>Number</u>	<u>Number</u>		<u>Number</u>	<u>Number</u>	<u>Inches</u>
Pre-whorl	Turgid & functional	1-5	2-3	---	---	---	---
Early whorl	do	6-7	3	---	---	---	---
Mid-whorl	Some shriveling & tipburn	8-9	4-5	---	---	---	---
Late whorl	extensive browning or lost	10	5-6	Shows in whorl cup	0-2	---	---
Early green tassel	---	10	2-4	Tip shows above edge of whorl	2-4	---	0-5
Mid green tassel	---	10-11	3	Clump of adhering branches	2-4	---	1-8
Late green tassel	---	11	0-1	Unfurled away from stem	3-5	0-a few	2-12 prominent on 2 shoots

- 1/ The first 2, or primary, leaf blades are usually lost or buried prior to the mid-green-tassel stage.
- 2/ Does not include the 2 primary leaf blades. Many strains of field corn show 13 or more leaf blades.
- 3/ Including all leaf blades that are rolled, at least at the base, and do not show a distinct line of juncture between the blade and the leaf sheath.

Table 2.--Characteristics of the silk, roasting-ear, and mature-growth stages (fig. 3) of the corn plant (based on examination of 100 plants).

Growth stage	Leaf blades visible	Tassel appearance	Peduncle	Anthers and pollen	Ear shoots and ears	Silk	Husk laminae
<u>Number</u>							
Early silk	11-15	Branches droop	Small portion shows above topmost leaf	Anthers dehiscing or opening	Husk leaves showing	Yellowish green, fresh and limited in number	Project forward from ear tip
Midsilk	11-15	Branches droop	May show 1 or more inches	Maximum pollen shedding	True ears distinct from rudimentaries	Colored, wilted at tips and numerous	Turned outward from ear tip
Late-silk	11-15	Branches straight and at an angle to stem	May show 1-6 inches	Anthers usually empty	Husk leaves tight around the ears	Dried and brown at tips only	folded back along side of ear
Roasting-ears ^{1/}	11-15	Branches straight and at an angle to stem	3-6 inches	Dry	One ear has reached full size	Dried and brown most of length	folded back along side of ear
Mature	11-15	Branches straight and at an angle to stem	3-6 inches	Dry	Less than 35 percent moisture in kernels	Dried and brown most of length	folded back along side of ear

^{1/} Sometimes called prime-milk, or green-produce ear.

The duration of any growth stage was found to vary with genetic strain, soil fertility, and weather. In early strains of sweet corn the plants passed from the early whorl to the late-silk stage in 30 to 45 days, depending on temperatures and rainfall in May and June. Mid-whorl and late-whorl stages lasted from 4 to 7 days each in early season sweet corn, but required a longer period in late-season sweet corn and field corn. The plants usually passed through the mid-green-tassel stage in 1 to 3 days. All growth stages were greatly prolonged, however, in strains of sweet corn or field corn that required a longer period to reach maturity.

Shelter areas on the plant are available to larvae of the European corn borer during each of the whorl, tassel, and silking growth stages of the corn plant. Such areas, characteristic of each stage, occur successively as the plants change in form through growth. Corn borer larvae are forced to migrate with the change or with the extinction of shelter areas; therefore larval establishment, migration, and reestablishment are affected by specific stages of plant growth. For these reasons the nomenclature of plant-growth stages described here is designed with reference to the sequence of biological events that take place on a corn plant.



Figure 1.--The whorl stages of growth of the corn plant (W_1 , W_2 , W_3), described in table 1: A, Early whorl; B, mid-whorl; and C, late-whorl stages.



Figure 3.--The silk stages of growth of the corn plant (S_1 , S_2 , S_3), described in table 2:
 A, Early silk; B, mid-silk; and C, late-silk stage.



Figure 2.--The tasseling stages of growth of the corn plant (T_1 , T_2 , T_3), described in table 1:
A, Early green-tassel; B, mid-green-tassel; and C, late-green-tassel stages.